

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD AND SPECIFICATIONS**

RIPARIAN FOREST BUFFER

(Acre)

CODE 391

DEFINITION

An area of trees and/or shrubs located adjacent to and up-gradient from water bodies.

PURPOSES

- Create shade to lower water temperatures to improve habitat for aquatic organisms.
- Provide a source of detritus and large woody debris for aquatic organisms.
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Create riparian habitat and corridors for wildlife.
- Mitigate flooding damage by trapping large debris and water-borne sediments, slowing flood waters, and lowering flood peaks.
- Provide a harvestable crop of timber, fiber, forage, fruit, or other crops consistent with other intended purposes.
- Restore natural riparian plant communities.
- Moderate winter temperatures to reduce freezing of aquatic over-wintering habitats.
- Increase carbon storage in plant biomass and soils.

CONDITIONS WHERE PRACTICE APPLIES

On areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands and areas with ground water recharge that are capable of supporting woody vegetation.

CRITERIA

General Criteria Applicable to All Purposes

The location, layout, width, length and density of the riparian forest buffer will accomplish the intended purpose and function to the water body.

See *General Specifications* for required plant densities for buffer plantings.

The buffer will consist of two zones. Zone 1 will begin at the normal water line or at the upper edge of the active channel or shore and extend 25 feet (measured horizontally on a line perpendicular from the watercourse). Zone 2 will begin immediately from Zone 1 and extend a minimum distance listed in the *Minimum Zone Widths* table below. Zone 1 and 2 additive distances equal the minimum required riparian forest buffer width.

Minimum Zone Widths

Stream Order	Zone 1	Zone 2	Total
1, 2	25 feet	25 feet	50 feet
3 and larger	25 feet	75 feet	100 feet
(3 exception*)	25 feet	25 feet	50 feet

* Third order streams that have surface flow for less than 6 months out of the year.

Stream order is a description of a drainage pattern. It is a measure of the position of a stream in the hierarchy of tributaries. First order streams are those which have no tributaries. Stream order increases when two streams of equal order join. For example it takes 2 second order streams joining to make a third order stream.

For buffer width requirements around wetlands, lakes and ponds use criteria for first and second order streams.

Dominant vegetation will consist of existing, naturally regenerated, or planted trees and shrubs suited to the site and the intended purpose. Use locally native species. Plantings will consist of two or more species with individual plants suited to the seasonal variation of the sites' soil moisture status. No single species will make up more than 50% of the total number of species planted.

Plant types and species shall be selected based on their compatibility in growth rates, flooding tolerance and shade value. *Refer to Table 1 for guidelines.*

In a newly established riparian forest buffer or an existing, understocked buffer, livestock will be excluded from all zones to allow re-vegetation of the area.

Occasional removal of some tree and shrub products such as high value trees is permitted provided the intended purpose of the riparian buffer is not compromised by the loss of vegetation or harvesting disturbance. Felling and skidding of trees shall be directed away from the water course or water body in a manner to prevent creation of ephemeral channels that concentrate flow to the water body.

Planting for establishing new buffers shall be done at a time and manner to ensure survival and growth of selected species. Refer to TREE/SHRUB ESTABLISHMENT (612) for care and handling requirements for woody planting material.

Only viable, high quality, and adapted planting material will be used.

The method of planting, including natural regeneration, for new buffers shall include techniques suited to achieving adequate woody survival. See TREE/SHRUB ESTABLISHMENT (612) for planting methods.

Site preparation shall be sufficient for the establishment and growth of selected species and is done in a manner that does not compromise the intended purpose. See FOREST SITE PREPARATION (490).

Protected entry points, water course crossings and livestock watering points shall be located and sized to minimize impact to riparian buffer vegetation and function.

Livestock shall be controlled or excluded as necessary from Zones 1 and 2 to achieve and maintain the intended purpose.

Livestock control must address grazing prescriptions that include duration, intensity, season/frequency of use, and alternative water sources. Impairment of planned riparian buffer function by livestock overuse (trampling, compaction, over utilization of woody cover, etc.) shall require immediate removal of livestock from the riparian area. Readjust livestock access to keep the riparian area fully functional.

Harmful pests present on the site will be controlled or eliminated as necessary to achieve and maintain the intended purpose.

Additional Criteria to Reduce Excess Amounts of Sediment, Organic Material, Nutrients and Pesticides in Surface Runoff and Reduce Excess Nutrients and Other Chemicals in Shallow Ground Water Flow.

Concentrated flow erosion or mass soil movement shall be controlled in the up-gradient area. A herbaceous Zone 3, immediately adjacent to Zone 2, shall be established and designed in accordance with criteria in FILTER STRIP (393).

Zone 2, for any stream order classification, may also be widened to include areas of overland out-of-bank flow that show evidence of scour erosion, debris deposits, or sediment deposition.

Maximum vigor of overstory and understory species shall be maintained.

Livestock will be excluded from all Zones, except for needed maintenance activities. See operation and Maintenance in FILTER STRIP (393).

Additional Criteria to Create Shade to Lower Water Temperatures to Improve Habitat for Aquatic Organisms.

Buffer species shall be capable of achieving desired height and crown density required for shade production. The buffer canopy shall be established to achieve at least 50 percent crown cover with an average projected (for the critical

shading time and month) canopy shade (shadow) length equal to or greater than the width of the water course or the area in need of shading. Refer to *Practice Specifications* for calculating shadow lengths.

Place drooping or wide-crowned trees and shrubs nearest the water course or body. Shoreline or channel relief (e.g., deeply incised channels) and topographic shading should be taken into account in selecting species and determining shadow lengths.

Additional Criteria to Provide a Source of Detritus and Large Woody Debris for Fish and Other Aquatic Organisms

Within Zone 1 and Zone 2, establish, favor or manage species capable of producing stems and limbs of sufficient size to provide an eventual source of large woody debris (>10 inches in diameter) for in-stream habitat for fish and other aquatic organisms. Refer to *Practice Specifications* for species recommendations.

All harvesting activities shall be excluded in Zone 1.

Additional Criteria to Create Riparian Habitat and Corridors for Wildlife

Develop Zones 1 and 2 for wildlife use. For criteria requirements, such as grazing control and preferred woody species, refer to *Missouri Wildlife Habitat Appraisal Guide* sheets for guidance. See also *Table 1* for species recommendations.

For riparian wildlife buffer width guidelines refer to *Practice Specifications*.

Additional Criteria to Mitigate Flooding Damage by Trapping Large Debris and Water-borne Sediments, Slowing Flood Waters and Flattening Flood Peaks

For the Missouri and Mississippi Rivers, Zone 2 will be widened a minimum width of 275 feet. The total width for Zones 1 and 2 will equal a minimum of 300 feet.

Zone 2, for any stream order classification, may also be widened, to include areas of overland out-of-bank flow that show evidence of scour erosion, debris deposits, or sediment deposition.

Select species that have good survival success from anticipated periods of extended flooding.

Refer to Table 1 in *Practice Specifications* for survival ratings.

Removal of tree and shrub products such as timber, nuts and fruit from all zones is permitted on a periodic and regular basis provided the intended purpose of the riparian buffer is not compromised by loss of vegetation or harvesting disturbance. Refer to *Practice Specifications* for recommended residual tree cover.

Additional Criteria to Stabilize Streambanks

Select or maintain species in Zone 1 that have medium/rapid growth characteristics. Encourage high plant densities and mixed aged stands.

Exclude livestock from Zone 1 and the streambank area. If livestock access is unavoidable, use protected entry points.

Correct problems with severely leaning trees that might contribute to potential unstable bank conditions.

Refer to STREAMBANK AND SHORELINE PROTECTION (580) for additional guidance.

CONSIDERATIONS

The severity of bank erosion and its influence on existing or potential riparian trees and shrubs should be assessed. Watershed-level treatment or bank stability activities may be needed before, or during, the establishment of a riparian forest buffer.

Complex ownership patterns of riparian areas may require group planning for proper buffer design, function and management. Use recommendations from regional or other large-scale evaluations and plans when designing, locating and connecting buffers.

Joining of new buffers with existing buffers increases the continuity of cover.

Buffers established on both sides will enhance multiple purposes.

Favor tree and shrub species that are native and have multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Consider species that resprout when establishing new rows nearest to water courses or bodies. For detritus and large woody debris, use species that will meet the specific

requirements of fish and other aquatic organisms for food, habitat, migration and spawning.

Avoid tree and shrub species which may be alternate hosts to undesirable pests or that may be considered noxious or undesirable. Species diversity should be considered to avoid loss of function due to species-specific pests.

The location, layout and density of the buffer should complement natural features. Avoid layouts and locations that would concentrate flood flows or return flows.

Consider the type of human use (rural, suburban, urban) and the aesthetic, social and safety aspects of the area to determine the vegetation selection, arrangement and management.

Use species selection to improve aesthetics, such as seasonal foliage color, showy flowers and fruit, foliage texture, form and branching habit. A landscape analysis can help determine specific aesthetic requirements.

Where feasible, consider alternative water sources, such as tanks, ponds, wells, solar pumps, and ram pumps, for livestock water supply needs.

A riparian forest buffer will be most effective when used as a component of a sound resource management system that includes integrated crop management and sediment and erosion control practices.

PLANS AND SPECIFICATIONS

Specifications for this practice shall be prepared for each site. Specifications shall be recorded using approved specifications sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance):

The riparian forest buffer will be inspected periodically and protected to maintain the intended purpose from adverse impacts such as excessive vehicular and pedestrian traffic, pest infestations, pesticide use on adjacent lands, livestock and wildlife damage, flooding and fire.

Replacement of dead trees or shrubs and control of undesirable vegetative competition will be continued until the buffer is, or will progress to, a fully functional condition.

Any removals of tree and shrub products shall be conducted in a manner that maintains the intended buffer purpose.

Any use of fertilizers, pesticides and other chemicals to assure buffer function shall not compromise the intended purpose or impact non-target species.

Manage the buffer to favor food, shelter and nesting cover that would satisfy the habitat requirements of target wildlife.

Biological control of undesirable plant species and pests (e.g., using predator or parasitic species, or grazing of domestic animals) shall be implemented where available and feasible.

Conduct maintenance activities (periodic harvests or thinning) to keep the riparian zones in a healthy, vigorously growing condition.

Additional operation and maintenance requirements shall be developed on a site-specific basis to assure performance of the practice as intended.

PRACTICE SPECIFICATIONS

Procedures, technical details and other information listed below provide additional guidance for carrying out selected components of the named practice. This material is referenced from the conservation practice standard for the named practice and supplements the requirements and considerations listed therein.

Plant List

Table 1 lists woody plant species (trees and shrubs) commonly associated with and suited to riparian areas. Key attributes are listed for each plant to assist with the design process for establishing new buffers.

Species are arranged alphabetically. Heights and attributes represent expected performance of individual plants on medium-textured, non-saline, neutral pH soils. Species in the Table represent trees and shrubs commonly associated in Missouri riparian ecosystems. This list is meant to be a guide and is not inclusive.

Planting Densities

Initial plant densities for trees and shrubs will depend on their potential height, crown characteristics and growth form. Planting density specifications are:

Plant Types/Heights: Plant-to-Plant Spacing
in feet:

Shrubs less than
10 feet in height 3 to 6

Shrubs and trees
from 10 to 25 feet
in height (includes
columnar trees) 5 to 8

Trees greater than
25 feet in height 8 to 12

Use of Air Root-Pruned Potted Stock

Sites that have a history of being wet or flooded may be planted using plants produced by an air root pruning method.

Air root-pruned material tend to be large plants, with thick, fibrous roots and capable of beginning seed production within 4 to 5 years.

Plants should be at least 4 feet tall with a minimum caliper of 1/2 inch. Plants should be planted by hand or an auger that creates a hole at least as wide as the container diameter.

Best results have been obtained when ridges or raised beds at least 12 inches high have been created and plants placed into these beds. Soil should be firmly packed around plant roots.

Weed barriers (fabric squares or linear lengths) may be used to control weed competition. Squares must be at least 4 feet by 4 feet, anchored with at least 9 wire staples at least 6 inches long.

Summer Sun Shadow Lengths

Listed below is a shadow length table for design tree heights in Missouri. To use this data, first select the critical shading month and solar time. Then choose the shadow length that equals the water body dimensions that need shading. The tree height value on the left will be the needed projected mature height for the design shading lengths.

Shadow Length (ft) Tables

Tree Height (ft)	10 AM and 2 PM		
	June	July	August
40	23	25	32
50	29	31	40
60	35	38	48
70	41	44	56
80	47	50	64
90	52	57	72

Tree Height (ft)	11 AM and 1 PM		
	June	July	August
40	15	17	24
50	19	22	30
60	23	26	36
70	27	30	42
80	30	35	48
90	34	39	53

Tree Height (ft)	12 Noon		
	June	July	August
40	12	14	21
50	15	18	26
60	18	21	32
70	21	25	37
80	24	28	42
90	27	32	47

Shadow lengths based on sun angles for solar time, 40 degrees north latitude. Source: ASHRAE Handbook, 1972.

Account for effective tree heights when determining shading lengths. Adjustments should be made for incised streams and topographic features that would add to the effective height of woody vegetation. For example, a tree 50 feet tall along an incised stream with normal flow elevation 10 feet below stream bank would have an effective tree height of 60 feet.

Residual Tree Guide for Trapping Large Debris and Slowing Flood Waters

Minimal stocking levels and size classes should be maintained to achieve the intended purpose of the riparian buffer.

The following chart can be used as a guide in determining residual stand goals.

Average tree DBH (inches)	Number of trees per acre	Average spacing (feet)
2-6	222	14
8-12	90	22
14+	38	34

Source: "Best Management Practices for upland and wetland forests." Hans Riekerk, 1991.

Riparian Wildlife Width Guidelines

The following guidelines represent the suggested minimum riparian forest buffer widths for selected species:

Species	Minimum Width
Cavity nesting ducks, bald eagle, heron rookery, pileated woodpecker, turkey	600 feet
Beaver, dabbling ducks, song birds, squirrels, mink	300 feet
Deer, frogs, salamanders	200 feet

REFERENCES

- Beeson, C. E. and P. F. Doyle. 1995. Comparison of bank erosion at vegetated and non-vegetated channel bends. *Water Resources Bulletin*. 31: 983-990.
- Burckhardt, J. C. and B. L. Todd. 1998. Riparian forest effect on lateral stream channel migration in the glacial till plains. *Journal of the American Water Resources Association*. 34:179-184.
- Dwyer, J.P., D.C. Wallace, and D.R. Larsen. 1997. "Implications of Woody River Corridors in Levee Protection Along the Missouri River in 1993". *Journal of American Water Resources Association*: Vol. 33, No. 2.

Roell, M. J. 1994. Considerations for Recommending Streamside Protection Zones in Missouri. Staffing Paper. Missouri Department of Conservation, Fish and Wildlife Research Center.

Kovacic, D.A., L.L. Osborne, and B.C. Dickson. 1991. "Effectiveness of Riparian Buffers in Reducing Pollution in the Agricultural Midwest." *Ecological Applications*

Schultz, R.C., J.P. Colletti, T.M. Isenhardt, W.W. Simpkins, C.W. Mize, and M.L. Thompson. 1995. Design and Placement of a Multi-species Riparian Buffer Strip. *Agroforestry Systems* 29:201-225.

U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, 1995. Forested Wetlands -- Functions, Benefits, and the Use of Best Management Practices. NA-PR-01-95.

U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, 1993. Crop Tree Management in Riparian Zones. Forest Resources Management.

U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, 1991. Riparian Forest Buffers -- Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91.

Wallace, D.C., W.A. Geyer, and J.P. Dwyer. April 2000. "Waterbreaks: Managed Trees for the Floodplain". *Agroforestry Notes*, AF Note-19. National Agroforestry Center, Lincoln, Nebraska.

Table 1. Plant List for Riparian Forest Buffers

Species (Common/Scientific)	Flooding Tolerance	Large Debris	Shade Value	Wildlife Merit	Height (feet)	Growth Rate	Soil Group
ash, green <i>Fraxinus pennsylvanica</i>	M	M	H	M	60	H	1,2
white <i>Fraxinus americana</i>	M	M	H	M	70	M	1
baldcypress <i>Taxodium distichum</i>	VH	M	M	M	80	M	1,2
birch, river <i>Betula nigra</i>	M	H	M	M	50	M	1,2
buttonbush <i>Cephalanthus occidentalis</i>	VH	L	L	L	10	M-H	2
cottonwood <i>Populus deltoides</i>	H	H	M	H	90	H	1,2
dogwood, silky <i>Cornus obliqua</i>	H	L	L	H	12	M-H	1,2
red-osier <i>Cornus stolonifera</i>	H	L	L	H	12	M-H	1,2
hackberry <i>Celtis occidentalis</i>	M-L	M	M	M	60	M	1
hawthorn, green <i>Crataegus viridis</i>	M	L	L	H	20	M	1,2
hickory, shellbark <i>Carya laciniosa</i>	M	M	H	H	70	M	1
holly, deciduous <i>Ilex opaca</i>	VH	L	L	M	16	M	1,2
maple, boxelder <i>Acer negundo</i>	M	H	M	M	40	H	1
silver <i>Acer saccharinum</i>	M-H	H	H	M	80	H	1,2
red <i>Acer rubrum</i>	M	M	H	M	70	M	1
oak, bur <i>Quercus macrocarpa</i>	H	M	H	H	80	L	1,2
pin <i>Quercus palustris</i>	M-L	H	M	H	75	M-H	1,2
Nuttall <i>Quercus nuttallii</i>	VH	M	H	H	70	M	2
willow <i>Quercus phellos</i>	M	M	H	H	70	M	1
overcup <i>Quercus lyrata</i>	VH	M	H	H	70	M	2
swamp white <i>Quercus bicolor</i>	M-H	M	H	H	70	M	1,2
cherrybark <i>Quercus pagodifolia</i>	M	M	H	H	75	M	1
shumard <i>Quercus shumardii</i>	M	M	H	H	80	M	1
pecan <i>Carya illinoensis</i>	M	M	H	H	80	L-M	1,2
persimmon <i>Diospyros virginiana</i>	M	M	M	H	50	L	1
privet, swamp <i>Forestiera acuminata</i>	VH	L	L	L	14	M	1,2
sugarberry <i>Celtis laevigata</i>	M-L	H	M	M	60	M	1
sycamore <i>Platanus occidentalis</i>	H	H	M	H	90	H	1,2
wahoo <i>Euonymus atropurpureus</i>	M-L	L	L	M	12	M	1
walnut, black <i>Juglans nigra</i>	M-L	M	M	H	80	M	1
willow, black <i>Salix nigra</i>	VH-H	H	L	M	60	H	1,2
sandbar <i>Salix exigua (interior)</i>	VH	L	L	L	6	H	1,2
peachleaf <i>Salix amygdaloides</i>	H	L	L	L	30	H	1,2
pussy <i>Salix discolor</i>	H	L	L	L	20	H	1,2

VH = very high; H = high; M = medium; L = low

Notes:

Flooding Tolerance. General capacity of the plant to withstand standing water. VH = able to survive deep, prolonged flooding for more than one year; H = able to survive deep flooding for one growing season, with mortality occurring if flooding is repeated the following year; M = able to survive flooding or saturated soils for 30 consecutive days during the growing season; L = unable to survive more than a few days of flooding during the growing season without mortality.

Large Debris. Potential for the plant to produce debris larger than ten inches in diameter before senescence. H = large debris likely within life span of the plant; M = large debris possible within life span of the plant; L = large debris unlikely within life span of the plant.

Shade Value. The density or fullness of shade provided by an individual plant's crown in full leaf-out condition. H = large crown providing full shade; M = partially open or medium sized crown that provides patchy or incomplete shade; L = very open or small crown that provides minimal shade.

Wildlife Merit. The potential for the plant to provide useful cavity sites and/or quality fruit production for wildlife. H = excellent large cavity potential and/or high quality fleshy fruit or nut production; M = moderate cavity potential or fruit production; L = low cavity potential and dry, non-nut fruit production.

Height. Typical potential height at physical maturity.

Growth Rate. The rate at which the plant grows in height during its development period (after seedling stage and before final maturity stage). H = Rapid growth of 3 or more feet per year; M = Medium growth of 1 to 3 feet per year; L = Low growth rates of generally less than 1 foot per year.

Soil Group. Trees and shrubs to plant based on soil suitability. Group 1 = somewhat poorly drained soils with a water table at 1 to 3 feet in the spring or subject to flooding. Permeability is moderately slow to rapid. Group 2 = poorly drained soils with slow to rapid permeability or somewhat poorly drained soils with slow permeability. Subject to ponding and/or frequent flooding.